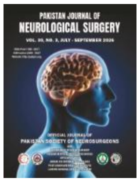

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Original Research

Burden and Patterns of Traumatic Brain Injury in a Tertiary Care Emergency Department in Punjab, Pakistan: A Retrospective Cohort Study

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ABSTRACT

Objective: Despite it being a developing epidemic of population health in low- and middle-income countries (LMICs), the granular epidemiological data on traumatic brain injury (TBI) remains limited. We examined the burden, mechanisms, and clinical outcomes of TBI in a large tertiary care environment in Punjab, Pakistan, to guide national neurotrauma policy.

Materials & Methods: The study's objective was to explore the epidemiological, clinical presentation, and outcomes of patients presenting with traumatic brain injury at Holy Family Hospital. It was a retrospective cohort study that evaluated 561 patients who presented with TBI to the emergency department of a tertiary teaching hospital from February 2024 to February 2025. Demographic, mechanism of injury, and Glasgow Coma Scale (GCS) data were obtained. Severity was categorized as mild (GCS 13–15), moderate (9–12), or severe (3–8). Chi-square and Fisher's exact tests were used to measure statistical associations.

Results: The cohort consisted mostly of males (n=448, 79.86 percent) with a mean age of 24.8 ± 21.0 years (range 1–96 years). The age group (2-10 years) was the greatest (n=197, 35.12 percent). The most common cause of injury was road traffic accidents (RTAs) (n=313, 55.79%), and then falls (n=239, 42.60%). The main mechanism in the pediatric population was falls as compared to RTA, which was significantly related to severe TBI ($p < 0.001$). The in-hospital mortality rate was 4.99, out of which 75 percent of the deaths were in the severe TBI group ($p < 0.001$).

Conclusion: TBI in Punjab has a bimodal vulnerability, with young children affected by falls and young adults by RTAs. The large percentage of serious injuries requires the adoption of universal triage mechanisms and the inclusion of TBI as a chronic disease into the national health system.

Keywords: Neurosurgery; Brain Injuries; Pakistan; Accidents; Public Health.

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INTRODUCTION

One fast-moving collision or fall may forever change the life of a human being. The so-called silent epidemic, traumatic brain injury (TBI), is not perceived as a simple acute clinical event anymore.[1] It is, instead, known as a complicated, extensive disease process that impairs brain functions and causes secondary injuries, which may last long [2]. It is estimated that around 69 million people across the globe have a TBI each year.[1,3] Nonetheless, there are big differences in results between high-income and low- and middle-income countries (LMICs).[2] This burden is localized in Pakistan and more so in the Punjab province through the influence of rapid urbanization and an increasing number of vulnerable road users.[4,5]

Modern studies have altered the paradigm of TBI management by considering it a long-term health issue instead of a single episode.[2,6] It is a chronic condition of neuroinflammation accompanied by increased susceptibility to late-onset neurodegenerative diseases, including Alzheimer disease and chronic traumatic encephalopathy.[2,7] Treatment in the first week following a severe head injury can decrease the likelihood of subsequent Alzheimer disease by as much as 41%.[8] In Pakistan, this crisis has a more socioeconomic effect since most of the injuries are among young adults in their most productive years.[4] With the international medical community shifting towards recognizing TBI as a notifiable and chronic disease via the World Health Assembly (WHA), there is a need to examine the epidemiological nature and systemic issues unique to the Pakistani neurotrauma environment.[9,10]

The epidemiology of TBI is a developing issue in the world. According to the data from the Global Burden of Disease (GBD) 2021 study, the incidence rates of age-standardized rates are decreasing on a global scale, although the number of cases increases in absolute terms.[1,11] The number of cases of TBI incidents was approximately 20.84 million per year in 2021, and the prevalence of TBI worldwide was 37.93 million.[11] In the region, the incidence rates are high in North Africa and the Middle East, especially in Pakistan, which is mainly caused by road injuries and interpersonal violence.[1,12]

TBI poses a critical health issue in the particular setting of Pakistan. Injuries represent 6.56 per cent of all deaths and 7.18 per cent of all disability-adjusted life years (DALYs) in the country.[13.14] The epidemiological profiles of Pakistan demonstrate the constant male dominance, and men make up 73% to 82% of the cases.[4,15] About 75 percent of these accidents involve motorcycles, but helmet use is at a pathetic low, with certain registries showing use rates of as low as 8.66 percent.[14,15]

Whereas the adult population comprises mostly RTAs, falls are the most common cause of TBI in children and the elderly. Children represent a majority (more than 35 percent) of the TBI presentations, and many of the injuries are caused by falling from heights, including unprotected roofs or trees in remote locations.[4] Diffuse axonal injury is more likely to occur in the pediatric brain due to its physiological vulnerability.[16] In addition, there is a dire lack of specialized pediatric rehabilitation services in Pakistan, and thus, most survivors experience permanent developmental disabilities.[17]

Pakistan has a weak trauma ecosystem that further impedes the clinical management of TBI.[13] Neurosurgery is a capital-intensive specialty that is not accessible to a large portion of the rural population. There is a dire lack of trained professionals in Pakistan, and the number of neurosurgeons is about 0.28 per 100,000 people, which is much lower than the global standard of 0.5 per 100,000.[18] This is increased by a brain drain in the workforce; according to nationwide surveys, 85.2 per cent of neurosurgery residents intend to emigrate after their training because of the poor working conditions and absence of research facilities.[19]

The cost of TBI is also truly staggering. In addition to direct healthcare expenditures, the disability caused by TBI takes up about 0.5% of the economic activity in the world.[2,10] In the case of a developing country such as Pakistan, in which a majority of the victims are primary breadwinners, one injury can lead to a spiral of intergenerational poverty.[13,17] Although organized rehabilitation has proven to decrease the incidence of cognitive impairment by 47.9 to 11.8 percent in Pakistani environments, such services have been peripherally sidelined in favor of acute surgical stabilization.[17] In 2024, the definition of global neurosurgery was brought together under the Peshawar Statement, which defined global neurosurgery as a social health practice focused on the provision of timely and fair care.[20] As a result of this impetus, Pakistan officially sponsored a historic resolution at the 78th World Health Assembly in May 2025.[9,10,21]

To solve the TBI crisis in Pakistan, it is necessary to shift the response from an acute emergency to a chronic disease model of response.[4,14] With the position of international policy, Pakistan can take advantage of the possibility to revise its internal trauma policies and enhance neuro-recovery routes. This study aims to provide the necessary epidemiological data from a tertiary care center in Punjab to inform these national strategies and improve the quality of survival for TBI patients.

MATERIALS AND METHODS

Study Design, Setting and Duration

This retrospective observational study was conducted at the emergency department of a tertiary care teaching hospital in Punjab, Pakistan (Holy Family Hospital, Rawalpindi), a major referral center providing 24-hour emergency and neurosurgical services to a large urban and rural catchment population. Data were collected over one year from **1st February 2024 to 1st February 2025**.

Ethical Considerations

The study was approved by the Departmental Review Board, / Ethical Review Committee of the Violence, Injury Prevention, and Disability Unit, Health Services Academy (Reference No# No-F,11-89/2022-DRB/VIPD/HSA/00054). Since it was a retrospective study that relied on anonymized patient records, informed consent was not needed, and patient information privacy was ensured throughout the research.

Inclusion Criterion

All patients presenting to the emergency department with a diagnosis of traumatic brain injury (TBI) during the study period were considered eligible for inclusion. Patients of all age groups and both genders were included, provided that complete medical records were available, particularly documentation of Glasgow Coma Scale (GCS) at presentation and mechanism of injury.

Exclusion Criterion

Patients with incomplete or missing key clinical data, those declared dead on arrival without adequate documentation, and those with non-traumatic causes of altered level of consciousness such as stroke or metabolic encephalopathy were excluded from the study.

Data Collection Procedure

Various hospital sources were used to gather data retrospectively, such as emergency department records, neurosurgery emergency notes, admission and ward registers, and patient medical files. Relevant variables were collected through the use of a structured data extraction form consisting of demographic variables (age and gender), clinical presentation (GCS score), mechanism of injury (road traffic accident, fall, assault, and other causes like firearm injury, electric shock, and stray bullet), specialty in which the patient was managed, and patient outcomes (survival or in-hospital mortality). Traumatic brain injury was a term used to refer to any damage to the brain due to some external mechanical force leading to the impairment of neurological functions temporarily or permanently. Injury severity was divided according to the Glasgow Coma Scale into mild (GCS 13-15), moderate (GCS 9-12), and severe (GCS 3-8).

Data Analysis

Statistical Package for the Social Sciences (SPSS) version 24 (IBM Corp., Armonk, NY, USA) was used to enter and analyze data. The summarization of the data was done using descriptive statistics, where categorical variables were represented using frequencies and percentages, whereas continuous variables were represented as mean + standard deviation. The Chi-square test or Fisher's exact test, where necessary, was used to inferentially test the relationship between categorical variables (age group, gender, and mechanism of injury) and the severity of TBI. The Chi-square test was also used to determine the relationship between severity of injury and patient outcomes (especially mortality). Less than 0.05 was statistically significant.

Operational Definitions

Traumatic Brain Injury (TBI): Any injury to the brain resulting from an external mechanical force and diagnosed clinically and/or radiologically, requiring evaluation or admission to the Neurosurgery Department.

Injury Severity: Injury severity was classified according to the Glasgow Coma Scale (GCS) at presentation as mild (GCS 13–15), moderate (GCS 9–12), and severe (GCS 3–8).

Road Traffic Accident (RTA): An RTA was defined as any injury sustained by a person (driver, passenger, motorcyclist, cyclist, or pedestrian) resulting from a collision involving one or more vehicles on a road.

Fall: An unintentional descent to the ground from height.

In-Hospital Mortality: In-hospital mortality was defined as death occurring during the index hospital admission following traumatic brain injury.

RESULTS

Patient Demographics

The study involved 561 patients who had traumatic brain injuries (TBI). Of these, 448 (79.86%) were male, and 113 (20.14%) were female. The mean age of the patients was approximately 24.8 ± 21.0 years (range 1–96 years). The highest proportion of patients, 197 (35.12%), belonged to the 2–10 years age group, followed by 21–30 years (17.83%) and 11–20 years (17.29%), as illustrated in Figure 1.

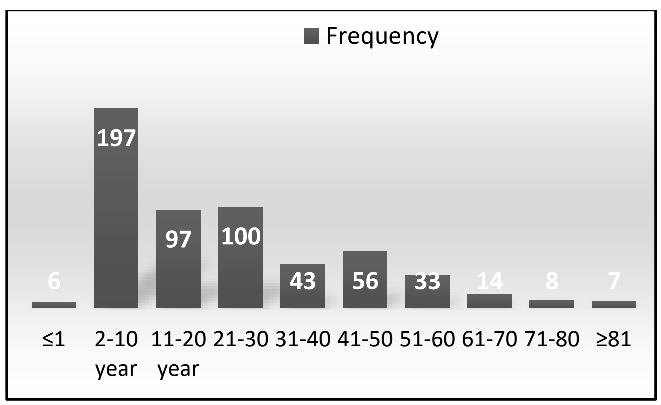

Figure 1: *Age-wise distribution of patients.*

Mechanism and Severity of Injury

Regarding the mechanism of injury, road traffic accidents (RTAs) were the most widespread, with

313 cases (55.79%), followed by falls (239 cases, 42.60%). The other less common causes were assault (0.89%), electric shock (0.18%), firearm injury (0.18%), and stray bullet injuries (0.36%), which are elaborated in Table 1.

Based on the severity of head injury assessed using the Glasgow Coma Scale (GCS), 288 patients (51.34%) had mild injury (GCS 13–15), 94 (16.76%) had moderate injury (GCS 9–12), and 179 (31.91%) had severe injury (GCS 3–8), as shown in Figure 3. The in-hospital mortality rate was 4.99% (n = 28), and further breakdown of the outcomes is presented in Table 4. Regarding specialty involvement, most of the patients were under the neurosurgery department (499; 88.95%), then pediatric surgery (36; 6.42%), orthopedics (18; 3.21), and plastic surgery (8; 1.43), as elaborated in Table 2.

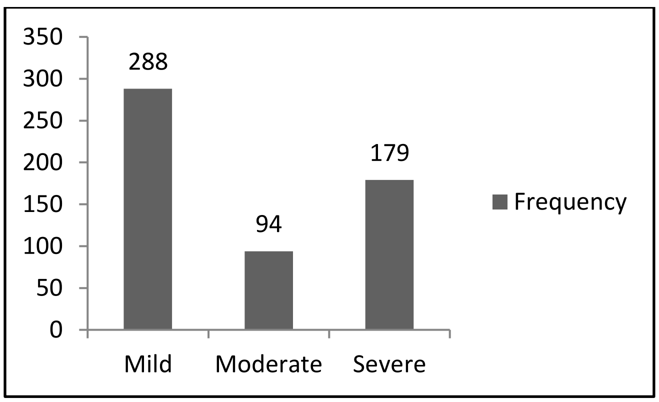

Figure 3: *Frequency distribution of patients based on head injury severity.*

Table 1: *Frequency distribution of patients based on mechanism of injury.*

Mechanism of Injury	Frequency	Percentage (%)
Fall	239	42.60%
RTA	313	55.79%
Assault	5	0.89%
Electric shock	1	0.18%
Firearm Injury	1	0.18%
Stray Bullet	2	0.36%

Pediatric and Elderly Findings

In the pediatric population, falls were identified as the most common mechanism of injury. Analysis of GCS distribution across age groups demonstrated that severe head injury (GCS 3–8) was more frequent at the extremes of age, particularly in younger children and elderly patients. Notably, all patients in the ≥81 years age group presented with severe head injury.

Association Between Variables and Injury Severity

Table 2 demonstrates the association between demographic and injury-related variables and the severity of traumatic brain injury as assessed by the Glasgow Coma Scale (GCS). A statistically significant association was observed between age group and injury severity ($p < 0.001$), with a higher proportion of severe head injuries noted at the extremes of age, particularly among pediatric (≤10 years) and elderly (≥71 years) patients.

No significant association was found between gender and injury severity ($p = 0.62$), with a comparable distribution of mild, moderate, and severe injuries among males and females.

The mechanism of injury showed a significant association with severity ($p < 0.001$). Patients sustaining injuries due to road traffic accidents (RTAs) had a higher proportion of severe head injuries, whereas falls were more frequently associated with mild to moderate injury.

There was also a high correlation between the severity of the injury and outcome ($p < 0.001$). Most of the deaths were among patients with severe head injury (GCS 3-8), and the mortality rate was much higher among these patients compared to patients with mild and moderate injuries.

DISCUSSION

The findings of this retrospective cohort study provide a detailed epidemiological account of traumatic brain injury (TBI) at a major tertiary

Table 2: *Association of Demographic and Injury-Related Variables with Severity of Head Injury (GCS Category).*

Variable	Category	Mild (GCS 13–15) n (%)	Moderate (GCS 9–12) n (%)	Severe (GCS 3–8) n (%)	Total (n)	p-value
Age Group (years)	≤1	1 (20.0)	0 (0.0)	4 (80.0)	5	**<0.001**
	2–10	118 (61.5)	30 (15.6)	44 (22.9)	192	
	11–20	55 (59.8)	13 (14.1)	24 (26.1)	92	
	21–30	47 (51.1)	13 (14.1)	32 (34.8)	92	
	31–40	21 (50.0)	9 (21.4)	12 (28.6)	42	
	41–50	20 (37.7)	13 (24.5)	20 (37.7)	53	
	51–60	12 (38.7)	6 (19.4)	13 (41.9)	31	
	61–70	4 (30.8)	3 (23.1)	6 (46.2)	13	
	71–80	1 (14.3)	1 (14.3)	5 (71.4)	7	
	≥81	0 (0.0)	0 (0.0)	7 (100.0)	7	
Gender	Male	230 (51.3)	75 (16.7)	143 (31.9)	448	**0.62**
	Female	58 (51.3)	19 (16.8)	36 (31.9)	113	
Mechanism of Injury	RTA	135 (43.1)	58 (18.5)	120 (38.3)	313	**<0.001**
	Fall	150 (62.8)	34 (14.2)	55 (23.0)	239	
	Others*	3 (33.3)	2 (22.2)	4 (44.4)	9	
Outcome	Survived	285 (53.5)	90 (16.9)	158 (29.6)	533	**<0.001**
	Death	3 (10.7)	4 (14.3)	21 (75.0)	28	

referral center in Punjab, Pakistan. Our cohort of 561 patients, spanning February 2024 to February 2025, reveals a pattern of bimodal age vulnerability, male predominance, and a dual mechanistic burden driven primarily by road traffic accidents (RTAs) and falls.

The overwhelmingly male composition of our cohort (79.86%) is consistent with patterns reported across South Asia and beyond. Shaukat et al, (2025) reported a male preponderance exceeding 80% among trauma admissions.[15] Kumar et al, (2026) documented male predominance in older trauma cohorts in Punjab, reinforcing the observation that gender disparities in trauma are not limited to any single age group.[4] Globally, the GBD 2021 study confirmed that males bear a disproportionate share of TBI incidence across nearly all world regions.[11] Worldwide, males are more likely to sustain a TBI; however, the consensus among the international literature is that injury severity is affected much more by mechanism and age than sex,[2] which matches our finding that gender was not an independent predictor of injury severity (p = 0.62).

The mean age of 24 ± 22 years in our cohort supports the observation that the burden of neurotrauma is disproportionately found among the economically active population. That aligns almost entirely with the results of Atiq et al, 5 have concluded that trauma admissions in the emergency department were often between 18–35 years of age.[5] The economic consequences are far-reaching; TBI-related disability in breadwinners launches spirals of household impoverishment that are most extreme in settings of limited social protection schemes.[13] Kumar et al, (2026), a prospective cohort the relationship between empirical and clinical consequences was also extended by examining a cohort of 700 trauma patients in Punjab, which found that long-term functional outcomes were worst among household heads, highlighting the relevance of the socio-economic dimensions of neurotrauma.[4]

The main mechanism was falls, with the 2–10 year age group being the largest single cohort (35.12%). In a GBD 2021 analysis by Yan et al., globally, falls are the number one cause of TBI among children aged<14 years.[11] Unprotected rooftops, open stairwells, and unsafe heights in agricultural environments produce a fall-hazard environment that disproportionately affects young children in rural Punjab, similar to other LMIC contexts.[25]. In a recent global review, Nkenguye (2024) noted that the incomplete myelination of the pediatric brain and the large head-to-body ratio predispose children to diffuse axonal injury and more global neurological injury compared to the focal injuries seen in adults, rendering even moderate falls potentially catastrophic.[16] Our data corroborate this, showing a higher proportion of severe GCS scores (GCS 3–8) at the pediatric extreme of age compared to mid-life adults, a statistically significant trend ($p < 0.001$).

At the other end of the age spectrum, elderly patients (≥71 years) in our cohort uniformly presented with severe TBI, with all patients aged ≥81 years categorized in the GCS 3–8 range. This finding resonates with the emerging global literature on geriatric neurotrauma. Kumar et al, (2025) specifically examined road traffic injury outcomes in the elderly population of Punjab and found substantially higher rates of severe injury, prolonged hospitalization, and in-hospital mortality compared to younger cohorts.[25] The physiological vulnerability of the ageing brain, including cerebral atrophy, increased subdural space, anticoagulant use, and impaired compensatory mechanisms, means that even lower-energy mechanisms such as ground-level falls can produce severe TBIs in the elderly.[2]

Road traffic accidents accounted for 55.79% of all TBI cases in our cohort and demonstrated a highly significant association with severe injury ($p < 0.001$), with 38.3% of RTA patients presenting in the severe GCS category compared to only 23.0% of fall patients. Shaukat et al, (2025) found that RTAs were the leading cause of high-severity trauma scores in their nationwide registry, with motorcycles implicated in the overwhelming majority of cases.[15] Khan and Hussain (2021) documented that motorcycles account for approximately 75% of road traffic accidents in Punjab's urban and peri-urban areas, a proportion that dwarfs the motorcycle involvement rates seen in high-income country registries.[14] This is particularly alarming given that helmet use in the same regional context has been documented at rates as low as 8.66% in some surveys. In high-income settings, a universal helmet law (with enforcement) has been associated with a 20–45% reduction in TBI-related mortality.[2]

The second most frequent mechanism is falls (42.60%) who require the same analytical attention. In contrast to RTAs, clustered almost completely in young adult males,[20] the burden of falls among our cohort was two-pronged, factoring in two separate, distinct demographic groups: young children (2–10 years); and older adults (≥61 years). Other LMIC settings have also described a bimodal fall pattern. Nzasabimana et al. A recent retrospective study of trauma burden in Rwanda, a resource-limited country similar to Pakistan in its healthcare infrastructure,[12] revealed that pediatric falls from heights and elderly same-level falls comprised two-thirds of all fall categories but would require different approaches to prevention.[13] Our findings suggest that a unified "falls prevention" strategy would be insufficient; instead, targeted environmental interventions for child safety (roof barriers, stair guards) and geriatric risk reduction (anti-slip flooring, medication review) are needed in parallel. The in-hospital mortality rate of 4.99% in our cohort may appear modest at first glance but requires careful contextualization. Among patients with severe TBI (GCS 3–8), 75% of all deaths occurred, and the association between injury severity and mortality was highly significant ($p < 0.001$). This proportion is consistent with the global literature: Maas et al, (2022), in their landmark Lancet Neurology review, reported case fatality rates of 30–40% for severe TBI in LMIC settings where neurosurgical care is delayed or unavailable, compared to 15–20% in well-resourced trauma systems.[2] Our lower overall mortality likely reflects a survivor selection bias inherent to in-hospital registries: patients who die before reaching tertiary care—estimated to constitute a substantial fraction of severe TBI deaths in Pakistan—are not captured in our dataset. Atiq et al, (2025) emphasized in their systematic review that pre-hospital mortality from trauma in Pakistan is substantially undercounted due to the near absence of formal emergency medical services and prehospital triage infrastructure.[5] Our reported 4.99% figure should therefore be interpreted as a floor estimate of true TBI lethality in this population.

The concentration of patient management within the neurosurgery department (88.95%) reveals a critical structural dependency in the trauma care pathway. The neurosurgeon-to-population ratio in Pakistan is around 0.28 per 100,000, which is almost half of the global benchmark of 0.5 per 100,000 recommended by the Lancet Commission on Global Surgery.[18] Such scarcity is further worsened by a critical geographic imbalance, with most of the neurosurgeons based in a few metropolitan centers (Lahore, Karachi, and Rawalpindi) and with rural Punjab, home to more than half of Pakistan's population, remaining acutely underserved.[20] Khan et al, (2025) performed a cross-sectional study that showed that 85.2% of surveyed neurosurgery residents in Pakistan planned to leave the country post-training, which they attributed mainly to inadequate pay, lack of research infrastructure, and limited opportunities for career progression.[19] This movement of talent strengthens a self-perpetuating cycle of workforce shortages that will not correct itself without changes in residency compensation and retention incentives.

The rehabilitation aspect of TBI management requires special consideration. Aziz et al. In a Peshawar study (2025), a structured, protocol-driven rehabilitation decreased the proportion of TBI survivors with cognitive impairment (47.9% vs 11.8%, a clinically significant decrease achievable in the Pakistani health system).[17] Yet, rehabilitation services continue to be excluded from trauma systems in Pakistan, which until now have been predominantly acute-focused.[21] This reconceptualization requires health systems to redesign care delivery to integrate chronic disease components such as longitudinal monitoring, neurobehavioral support, and incorporation of TBI survivors into chronic disease management pathways.[6]

Pakistan co-sponsored the landmark Resolution WHA78 at the 78th World Health Assembly in May 2025, which urges member states to explicitly acknowledge TBI as a notifiable and chronic condition and to create national neurotrauma registries.[9] Khattak et al, (2026) wrote in their post-WHA78 advocacy commentary that this resolution provides an evidence-based normative context that allows countries such as Pakistan to justify the establishment of dedicated neurotrauma resources.

In Rwanda, Nzasabimana et al. According to (2023), financial discrepancies, geographic inaccessibility, and lack of prehospital care were recognized as the three pillars blocking the pathway to equitable receiving of care post-trauma, all of which are echoed within the Pakistani setting.[13] By contrast, high-income countries have gradually transitioned toward precision neurotrauma medicine with biomarker-guided triage, advanced neuroimaging, and multimodal monitoring in the acute phase.[2] The 2024 NINDS classification project, analyzed by Nelson et al, (2025) proposed a new TBI framework that is intended to be resource-agnostic, being conceptually adaptive through a tiered implementation strategy.[29]

Overall, the findings of this study provide some evidence of the need for a paradigm shift in the way that Pakistan should conceptualize and respond to TBI. A comprehensive national approach requires collaborative action across prevention (helmet law enforcement, child home-safety programs, elderly fall reduction), acute care (prehospital triage capacity, expansion of our neurosurgical workforce, standardized GCS-based triage protocols), and rehabilitation (regional rehabilitation centers, post-discharge monitoring, caregiver support). In 2024, the Peshawar Statement[20] on global neurosurgery mapped neurosurgical care to social justice, highlighting that access to timely neurotrauma care is a matter of access to development.

Recommendations

Priority interventions include stronger road safety legislation, promotion of pediatric injury prevention, implementation of uniform trauma triage guidelines, and development of regional trauma registries. This will likely require investment in prehospital care, timely neurosurgical referral pathways, and national neurotrauma surveillance systems to better characterize the TBI burden in Pakistan.

Limitations of the Study

While this study provides crucial insight into the landscape of neurotrauma in Pakistan, it has several limitations:

- Retrospective nature of the study: The previous hospital records, retention register, and emergency notes could have biased documentation or may have selected patients with complete files.
- Single-Center Scope: Since the data were gathered in a single tertiary care hospital, the results might be limited to the locality of Rawalpindi and its area instead of the whole province.
- Mortality underestimation: Our mortality rate (4.99%) includes only in-hospital deaths. Limitations include that it does not reflect pre-hospital fatalities or chronic post-discharge mortality, which might be less representative of genuine TBI lethality.
- Lack of Long-term Follow-up: The work described cannot answer important questions regarding functional recovery, cognitive impairment, and the natural evolution of a traumatic brain injury into a chronic disease state, which are all high priorities for all international neurotrauma efforts.

CONCLUSION

We hereby elucidate the dismal figures of traumatic brain injury in Pakistan. The noteworthy correlation between the low GCS scores and mortality highlights the importance of timely neurosurgical treatment and patient stabilization. Pakistan needs to shift its approach to the basic principles of public health. This would involve the implementation of helmet laws, enhancing pediatric safety culture, generating local datasets on trauma and emergency, streamlining referrals from primary and secondary care, and establishing operationalized trauma protocols according to Pakistan's local context.

REFERENCES

1. Jawed A, Shabanpour A, Gupta N, Tudor D, Ghandi Y, Mohebi A. A global snapshot of the silent brain injury epidemic: A descriptive observational study of concussion coverage on YouTube. Health Promot Perspect. 2025;15(2):146-52.
Doi: 10.34172/hpp.025.44339.
2. Maas AI, Menon DK, Manley GT, Abrams M, Åkerlund C, Andelic N, et al. Traumatic brain injury: progress and challenges in prevention, clinical care, and research. Lancet Neurol. 2022;21(11):1004-60. Doi: 10.1016/S1474-4422(22)00309-X.
3. Dewan MC, Rattani A, Gupta S, Baticulon RE, Hung YC, Punchak M, et al. Estimating the global incidence of traumatic brain injury. J Neurosurg. 2018;130(4):1080-97.
Doi: 10.3171/2017.10.JNS17352.
4. Kumar K, Ghazi KR, Abdul Rahim K, Musharraf MB, Hassan S, Akhtar Sheikh S, et al. Long-Term Outcomes Following Traumatic Injury in Older Adults in Pakistan: A Prospective Cohort Study. J Surg Res. 2026;321:212-8.
Doi: 10.1016/j.jss.2026.02.015.
5. Atiq H, Rahim KA, Shiekh SA, Afzal B, Wajidali Z, Chand ZB, et al. Access to quality trauma care after injury in Pakistan: a systematic review and narrative synthesis. BMJ Open. 2025;15(12):e101071.
Doi: 10.1136/bmjopen-2025-101071.
6. Corrigan JD, Hammond FM, Sander AM, Kroenke K. Recognition of Traumatic Brain Injury as a Chronic Condition: A Commentary. J Neurotrauma. 2024;41(23-24):2602-5.
Doi: 10.1089/neu.2024.0356.
7. Ahmed S, Venigalla H, Mekala HM, Dar S, Hassan M,

Ayub S. Traumatic Brain Injury and Neuropsychiatric Complications. Indian J Psychol Med. 2017;39(2):114-21. Doi: 10.4103/0253-7176.203129.

8. Mohamadpour M, Whitney K, Bergold PJ. The Importance of Therapeutic Time Window in the Treatment of Traumatic Brain Injury. Front Neurosci. 2019;13:7. Doi: 10.3389/fnins.2019.00007.
9. Khattak AF, Mediratta S, Venturini S, Smith BG, Dubetz PT, Barthélemy EJ, et al. Global Recognition of Traumatic Brain Injury as a Chronic and Notifiable Condition: A Post-WHA78 Advocacy Commentary. Brain Sci. 2026;16(2):134. Doi: 10.3390/brainsci16020134.
10. Corrigan JD, Hammond FM. Traumatic brain injury as a chronic health condition. Arch Phys Med Rehabil. 2013;94(6):1199-201. Doi: 10.1016/j.apmr.2013.01.023.
11. Yan J, Wang C, Sun B. Global, regional, and national burdens of traumatic brain injury from 1990 to 2021. Front Public Health. 2025;13:1556147. Doi: 10.3389/fpubh.2025.1556147.
12. Steinmetz JD, Seeher KM, Schiess N, et al. Global, regional, and national burden of disorders affecting the nervous system, 1990–2021: a systematic analysis for the Global Burden of Disease Study 2021. Lancet Neurol. 2024;23(4):344-81. Doi: 10.1016/S1474-4422(24)00038-3.
13. Nzasabimana P, Ignatowicz A, Alayande BT, et al. Barriers to equitable access to quality trauma care in Rwanda: a qualitative study. BMJ Open. 2023;13(9):e075117. Doi: 10.1136/bmjopen-2023-075117.
14. Khan MAH, Hussain I. Analysis of Road Traffic Accidents in the Punjab by Using Panel Count Data Models. Stat Comput Interdiscip Res. 2021;3(1):1-13. Doi: 10.52700/scir.v3i1.23.
15. Shaukat N, Musharraf MB, Rahim KA, et al. High trauma mortality and severe injury burden in Pakistan: epidemiology, surgical interventions, and in-hospital care from a digital hospital-based trauma registry. Eur J Trauma Emerg Surg. 2025;51(1):312. Doi: 10.1007/s00068-025-02978-5.
16. Nkenguye W. Impacting lives: The silent crisis of pediatric traumatic brain injury. IJS Glob Health. 2024;7(2):e0427. Doi: 10.47392/ijsg.2024.427.
17. Aziz A, Asma B, Ahmad S, Jan I. Impact of structured rehabilitation on quality of life in traumatic brain injury patients at tertiary care hospitals in Peshawar. IJHR-J Health Rehabil. 2025;3(8):i1123. Doi: 10.71000/cqdj4x78.
18. Ali S, Sharif S, Amin F. Benchmarking of neurosurgery training in Pakistan. Asian J Neurosurg. 2021;16(02):300-6. Doi: 10.4103/ajns.AJNS_426_20.
19. Khan B, Khan MS, Shah SS, Ahmad SJ, Rehman ZU, Chaurasia B. Career trends among neurosurgery residents in Pakistan: A cross-sectional study. Medicine. 2025;104(50):e46445. Doi: 10.1097/MD.0000000000046445.
20. Javed S, Asif MA, Yaqoob E, Mushahid Z, Arshad MM, Farooq M, Chaurasia B. Neurosurgical landscape in Pakistan: Past, present and future perspectives. J Clin Neurosci. 2024;120:115-9. Doi: 10.1016/j.jocn.2024.01.005.
21. Marklund N, Bellander BM, Godbolt AK, Levin H, McCrory P, Thelin EP. Treatments and rehabilitation in the acute and chronic state of traumatic brain injury. J Intern Med. 2019;285(6):608-23. Doi: 10.1111/joim.12900.
22. Yan J, Wang C, Sun B. Global, regional, and national burdens of traumatic brain injury from 1990 to 2021. Front Public Health. 2025;13:1556147. Doi: 10.3389/fpubh.2025.1556147.
23. Nzasabimana P, Ignatowicz A, Alayande BT, et al. Barriers to equitable access to quality trauma care in Rwanda: a qualitative study. BMJ Open. 2023;13(9):e075117. Doi: 10.1136/bmjopen-2023-075117.
24. Nkenguye W. Impacting lives: The silent crisis of pediatric traumatic brain injury. IJS Glob Health. 2024;7(2):e0427. Doi: 10.47392/ijsg.2024.427.
25. Aziz A, Asma B, Ahmad S, Jan I. Impact of structured rehabilitation on quality of life in traumatic brain injury patients at tertiary care hospitals in Peshawar. IJHR-J Health Rehabil. 2025;3(8):i1123. Doi: 10.71000/cqdj4x78.
26. Khattak AF, Mediratta S, Venturini S, Smith BG, et al. Global Recognition of Traumatic Brain Injury as a Chronic and Notifiable Condition: A Post-WHA78 Advocacy Commentary. Brain Sci. 2026;16(2):134. Doi: 10.3390/brainsci16020134.
27. Nelson LD, Wilson L, Albrecht JS, et al. Toward more holistic early traumatic brain injury evaluation and care: recommendations from the 2024 NINDS TBI classification and nomenclature initiative. J

Neurotrauma. 2025;42(13-14):1023-37.
Doi: 10.1089/neu.2025.0045.

28. Dams-O'Connor K, Juengst SB, Bogner J, et al. Traumatic brain injury as a chronic disease: insights from the United States traumatic brain injury model systems research program. Lancet Neurol. 2023;22(6):517-28.
Doi: 10.1016/S1474-4422(23)00107-4.

Marklund N, Bellander BM, Godbolt AK, Levin H, McCrory P, Thelin EP. Treatments and rehabilitation in the acute and chronic state of traumatic brain injury. J Intern Med. 2019;285(6):608-23.
Doi: 10.1111/joim.12900.

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Sr. #	Author's Full Name	Intellectual Contribution to Paper
1.	Eesha Yaqoob	Conceptualization, methodology, project administration, supervision, writing – original draft, writing – review & editing, validation
2.	Shafiq-ur-Rehman Jamil	Data curation, investigation, writing – original draft, writing – review & editing, validation
3.	Mohsin Ali Nadir	Data curation, formal analysis, investigation, writing – original draft, writing – review & editing, validation
4.	Muhammad Usman Malik	Formal analysis, resources, writing – original draft, writing – review & editing, validation
5.	Soban Sarwar Gondal	Writing – original draft, writing – review & editing, validation
6.	Saad Javed	Conceptualization, methodology, formal analysis, writing – original draft, writing – review & editing, validation